MAPPING THE DEAVERTOWN (7.5') QUADRANGLE

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I would like to thank everyone at the Ohio Division of Geological Survey for their help and encouragement especially Mac Swinford for his patient guidance on this thesis and Dick Carlton for the use of his office, equipment, and methods. I would like to thank Mike Hansen for agreeing to be my thesis advisor. Ernie Slucher's help in the field was invaluable and Glenn Larsen and Doug Shrake answered quite a few questions. Allan Axon, Ray Klingbeil, and Larry Wickstrom allowed me to draw on their computer graphics skills to produce the maps, especially the color map. Finally, I want to thank my daughters, family, and friends for their support.

METHODOLOGY

I began by choosing the quadrangle that I would be mapping. Mappers at the Ohio Department of Natural Resources, Division of Geological Survey were mapping bedrock in Perry County. I chose to work within their project area so that they could use my information. I have interned with Richard W. Carlton working on the National Coal Resources Data System (NCRDS) project and knew that information had been compiled on the Crooksville (7.5′) and Philo (7.5′) Quadrangles which lie directly to the north of the Deavertown (7.5′) Quadrangle. Also, because of my intern experience, I was familiar with the unglaciated formations in Ohio.

I made copies of all of the Measured Section and Drill Hole records that applied to the Townships that encompassed the Deavertown Quadrangle: these records are on file at the Survey. I also made a copy of the New Lexington (15′) Quadrangle because it includes the Deavertown Quadrangle and contains the locations of the Measured Sections. With this information, I tried to choose outcrops to visit with Ernie Slucher and Doug Shrake. I learned how to identify two of the key limestone beds in this area and observed some Ohio mapping techniques from Mr. Slucher. I made observations in the field a few times during the winter and late spring of 1995.

I did most of the mapping by computer. I encoded the information from the Measured Sections and Drill Hole records in order for them to be keypunched into the computer using the formats set up by Dick Carlton for NCRDS.

Next, using the locations given on the New Lexington (15′)

Quadrangle and the elevations given or deduced for the surface at each Measured Section or Drill Hole location, I plotted these points on a map of the Deavertown Quadrangle. These points were then entered into the computer by digitizing them using Microstation.

The Microstation files of the locations and the keypunched files with the stratigraphic information were then imported into the StratiFact program. This enabled the data to be arranged stratigraphically and by location because it correlated the two files by the Measured Section or Drill Hole identification numbers.

Because the Deavertown (7.5') Quadrangle is a small area, the contouring that StratiFact would have done would have contained edge effects due to the lack of data outside the area. Therefore, the NCRDS data for the Crooksville (7.5') and Philo (7.5') Quadrangles were attached to the Deavertown file. Then, I gathered data from nearby portions of the remaining surrounding quadrangles and entered that data into StratiFact.

Next, I edited the StratiFact information and used the program to produce structure contour maps. At first, I generated six maps on the Ames, Cambridge, and Brush Creek Limestones and on the Mahoning, Mason, and Upper Freeport Coals. After I edited the structure contour maps for bad points and lack of information, I ended up with three good structure contour maps for the Ames Limestone, the Brush Creek Limestone, and the Upper Freeport Coal. The files were imported into a Unix-based Sun computer and the three structure contour maps were plotted on mylar.

I overlaid the three structure contour maps to check for cross-overs and then each structure contour map was placed separately under the mylar topographic map. I inked each contact using the appropriate symbology. An explanation (key) and a stratigraphic column were also inked onto the mylar. (See Figure 9 for a copy of the stratigraphic column and a paper copy of the Open file Map - the mylar- can be found in the front pocket.)

INTRODUCTION

The Deavertown (7.5′) Quadrangle is located in southeastern Perry County. It forms the northeast 7.5′ quadrangle of the New Lexington (15′) Quadrangle (Figure 1). The rocks that crop out here are predominantly Pennsylvanian age and they dip gently eastward off of the Cincinnati Arch. This part of Perry County is unglaciated and averages about five-hundred feet of relief in the southeastern portion of the county (Flint, 1951).

This quadrangle consists mostly of the Pennsylvanian-age Conemaugh Group (Figures 3 and 4). In this quadrangle, the Conemaugh Group "includes the cyclothems from the Mahoning up through the Harlem," which is about one-half of the fifteen cyclothems in the Conemaugh series (Flint, 1951).

The stratigraphy of Perry County was grouped into cyclothems by Flint (1951). A cyclothem is a unit of rocks that consists of thin beds of sandstone, shale, clay, ironstone, and freshwater and marine limestones. The cyclothem is named according to the included coal bed and all the beds in that cyclothem then go by that characteristic name. For example, the sandstone that lies underneath the Mahoning Coal bed is called the Lower Mahoning Sandstone. A cyclothem is a large-scale "repetitive orderly arrangement of different kinds of sediments" caused by long term "migration of depositional environments" (Boggs, 1987).The cyclothem is marked by a disconformity that occurred as environmental conditions changed from non-marine to marine. The boundary between cyclothems is drawn at the contact between these marine fossiliferous beds below and the non-marine unfossiliferous beds above (Flint, 1951). Therefore, this boundary occurs between a coal and a shale or sandstone unit. See Figure 2 for an example from Flint (1951) of a typical cyclothem and Figures 6 and 7 from Collins (1979) for the generalized stratigraphic columns for the Allegheny and Conemaugh Groups that give the names of the beds as they occur in the cyclothems.

The lower half of the Conemaugh Group consists primarily of marine deposits, including the Ames Limestone marker bed, and persistent coal beds. Erosion surfaces and unconformities are common in the beds of the Conemaugh Group and are present as truncated beds and conglomerates. The marine limestone deposits are the most continuous and lithologically uniform beds of this group. However, they also have local discontinuities where shoals may have been present or where rivers eroded the marine beds (Condit, 1912).

The upper beds consist of sandstone, red beds, freshwater limestones, and lenticular coals. The Mahoning Sandstone marks the first red bed of the Pennsylvanian. The red beds of the Conemaugh give evidence of drier terrestrial conditions. In the Conemaugh, the sandstone deposits are usually cross-bedded and lenticular. The shales contain ripple marks and mudcracks which indicate a marginal marine or tidal environment of deposition (Condit, 1912).

The Conemaugh is a little less than three-hundred meters thick in Maryland but it thins to the west, becoming about ten meters thick in eastern Ohio. Most of the marine fossils of this group are found in the Ames Limestone and consist mostly of brachiopods, clams, and snails (Branson, 1962). The Conemaugh is also rich in terrestrial plants, including spores (Condit, 1912).

GEOLOGY

The Upper Freeport Coal bed marks the Allegheny-Conemaugh Group boundary. The coal occurs sporadically, and this, according to Condit (1912), was because of: (1) organic material that was exposed and therefore failed to accumulate, (2) only limestone formed because subsidence was too great for organic deposition, or (3) the coal beds eroded.

The Mahoning interval varies from massive to lenticular sandstone to shale, which may indicate that the sandstone was deposited in energetic current while the shale was deposited in less energetic water nearby. In the middle of Mahoning time, clay, calcareous beds, and the Mahoning Coal were deposited. The Mahoning Coal is very undulous and contains evidence of stream erosion and replacement with sandstone. The Mahoning Coal was deposited in peat swamps and was later covered with sandy deposits. Although the transgression of the Brush Creek sea caused the deposit of fossiliferous beds in many areas, the sandy deposits of the Mahoning interval continued to accumulate in this region (Condit, 1912).

The Brush Creek interval represents the longest lasting marine conditions of the Conemaugh Group as displayed by fossiliferous beds that may be up to 3.05 meters. The discontinuity of the Brush Creek beds may represent subareal areas or brackish shoals near river mouths that were in place at the time of deposition. This marine deposition is covered by sediments that are increasingly sandy, which formed the

Buffalo Sandstone. There are no marine fossils found in the Buffalo and only a few plant remains. It is thought that the shore gradually receded as river deposition occurred (Condit, 1912).

The Cambridge Limestone, a transgressional limestone, is siliceous with some intercalated flint beds that formed from the diagenetic silicification of the limestone. It was deposited over the Brush Creek interval and a subsequent coal bed. The presence of the Wilgus Coal bed is evidence of a gradual transgression that encouraged the formation of swamps. In parts of Athens and Meigs Counties, massive, coarse-grained, non-fossiliferous sandstone was deposited instead of the more continuous Wilgus bed (Condit, 1912).

The Anderson Coal is covered by the fossiliferous, calcareous Portersville Shale which shows similar deposition to the Cambridge Limestone. However, the Portersville Shale is much more continuous than the Cambridge Limestone and is found throughout the Conemaugh in Ohio (Condit, 1912).

The coal beds, including the Anderson, found below the Cambridge and the Portersville intervals are overlain by shales that contain abundant marine fossils. The coal was deposited and then was buried by a marine transgression. The end of marine deposition seems to be caused by sedimentation rather than by uplift. Fossiliferous beds are overlain by sandy beds with few organic remains, indicating brackish conditions, according to Condit (1912).

The Ewing Limestone, found between the Portersville and the Ames Limestones, is non-marine. It contains ostracodes, fish teeth, and some reptile bones. It too was cut by streams because limestone conglomerates are found at the base of sandstone that was deposited by streams. The deposition of red beds (clays) began at about this period and continued through the remainder of the Conemaugh period. The thinner red beds that are found in lower members are red because of recent oxidation. Unexposed beds are bluish-gray. The red beds extend up to and past the Ames Limestone. These clay beds contain hematite nodules and impressions of marine fossils that indicate a lagoonal depositional environment. The lack of carbonaceous material also indicates high salinity water because it is thought that higher salinity inhibits plant growth. Even though the upper red beds owe their color to disseminated iron oxide (a characteristic of the Conemaugh Group), there are few if any beds of iron ore (Condit, 1912).

The Ames Limestone is a greenish-gray, crystalline limestone that contains many crinoid stem fragments. The limestone bed ranges between .3 and .76 meters thick. It occurs as a single persistent bed and "is the highest unit that can be reliably traced" in Perry County (Flint, 1951).

According to Collins (1979) and others, some geologists believe that the sedimentary deposits of Pennsylvanian-age rocks in the Appalachian basin, especially in the north, resemble the sediments of modern deltas so closely that Ferm and Cavaroc (1969) used the same terminology to describe both. However, Joeckel (1995) proposes that the Ames Limestone was deposited as the result of a widespread marine transgression that was produced by tectonics or by a rise in sea level (glacioeustasy). Mudstones that contain paleosol features, such as large slickensides, calcite nodules, and mottling, were deposited under the Ames Limestone at the same time as the Harlem Coal. According to Joeckel, the pre-Ames landscape, based on features of the Ames-Harlem interval, show that the landscape had significant local relief which consisted of shallow valleys with broad "interfluves." The paleosols indicate seasonal climatic changes (the slickensides indicate wet/dry cycles). The Harlem Coal deposits resulted from drainage pattern changes as the Ames transgression began. As the sea level rose, water tables became perched and the previous drainage "ponded" instead of flowing on out to sea. This scenario could have produced the sporadic deposits of Harlem Coal that are found in the Appalachian basin today (Joeckel, 1995). (See Figure 8 for a diagram of this theory.)

The Pittsburgh Coal bed marks the Conemaugh-Monongahela Group boundary and it overlays numerous limestone beds. The red color is missing from the clay layers at this point. The uppermost bed of the Conemaugh Group is the Pittsburgh Limestone. In eastern Ohio, the limestone is interbedded with clay-shale and clay. Some portions of the Pittsburgh Limestone have a conglomeratic structure. Hyde (1908) stated that these conglomerates were composed of rounded, pebbly fragments that were formed in lime and exposed to the sun. He termed them dessication conglomerates, although Boggs (1987) calls them flat-pebble conglomerates. As the depositional surface dried out and mudcracks formed, it was submerged during a transgression, was broken forming pebbles, and was finally overlain by shale deposits (Condit, 1912).

FOSSILS

Forty-two genera and ninety-three species and varieties of marine fauna occur in the Pennsylvanian Formations. This is less diversity than that found in the Western Interior basin and is probably the result of less favorable environments and limited migration (Sturgeon and Hoare, 1968). Marine fossils are found in the Brush Creek, Cambridge, and Ames Limestone units. Sturgeon and Hoare (1968) list the following distinctive brachiopods included in these units: Derbyia parvicostata, Wellerella osagensis, Enteletes hemiplicatus, Orthotetes conemaughensis, Punctospirifer kentuckyensis var. amesi, Composita ohioense, C. magna, Neochonetes semiacanthus, N. granulifer, Chonetinella alata, C. flemingi, Hystriculina wabashensis, Pulchratia cf. P. ovalis, P. symmetrica var. regularis, Echinaria semipunctata, E. moorei, Antiquatonia portlockiana var. crassicostata, Retiulatia huecoensis, Juresania nebrascensis var. pulchra, and Linoproductus cf. L. oklahomae. According to Smyth (1957), three distinctive fusulinids are found in the Conemaugh Group: Triticites ohioensis, T. skinneri, and T. cullomensis. Cephalopods are fairly common in the Brush Creek and the Ames Limestones and plant fossils are common throughout the Conemaugh Group (Condit, 1912).

ECONOMIC PRODUCTS

Although across Ohio, coal is the most important mineral resource, it is not very significant in the Conemaugh Group. In Perry County, according to the 1993 Report on Ohio Mineral Industries, 385,016 short tons of coal were produced from the Middle Kittanning Coal (No. 6) and 10,305 short tons were produced from the Lower Kittanning Coal (No. 5). The Upper Freeport and other coals have been mined in the past and locally in the Deavertown area although no production has been reported for recent years. According to Collins (1979), "depletion of reserves, changes in mining methods, and economics" have reduced the economic importance of the Upper Freeport Coal seam.

Collins (1979) also states that the clay beds of the Conemaugh Group are thin and discontinuous and are not mined. However, although the 1993 Mineral Industries Report does not separate the Perry County figures by Township, Perry County produced 63,243 tons of clay and 39,940 tons of shale mostly for common clay products.

The 1993 Report on Ohio Mineral Industries states that 386,989 tons of crushed sandstone and conglomerate were produced for glass sand (254,233 tons), silica flour (89,794 tons), and foundry sand (11,915 tons). Quarry operators in the county produced 281,899 tons of crushed or broken limestone or dolomite which was mostly used for road construction or resurfacing (1993 Ohio Minerals Industry Report). Other freshwater limestones of the Conemaugh Group, especially the Brush Creek Limestone, have been mined locally for agricultural lime and for road metal (Collins, 1979).

Although reliable figures for the amount of oil and gas produced in Perry County were not available, the 1993 Report on Ohio Mineral Industries stated that twenty-four wells were completed out of thirty-seven wells that were drilled in 1993.

CONCLUSION

I enjoyed working on this map for my thesis and learning the process step by step from beginning to finished product. In order to do a more complete map, I would (with hypothetical funding) have liked to spend more time in the field gathering more original, and hopefully more accurate, information.

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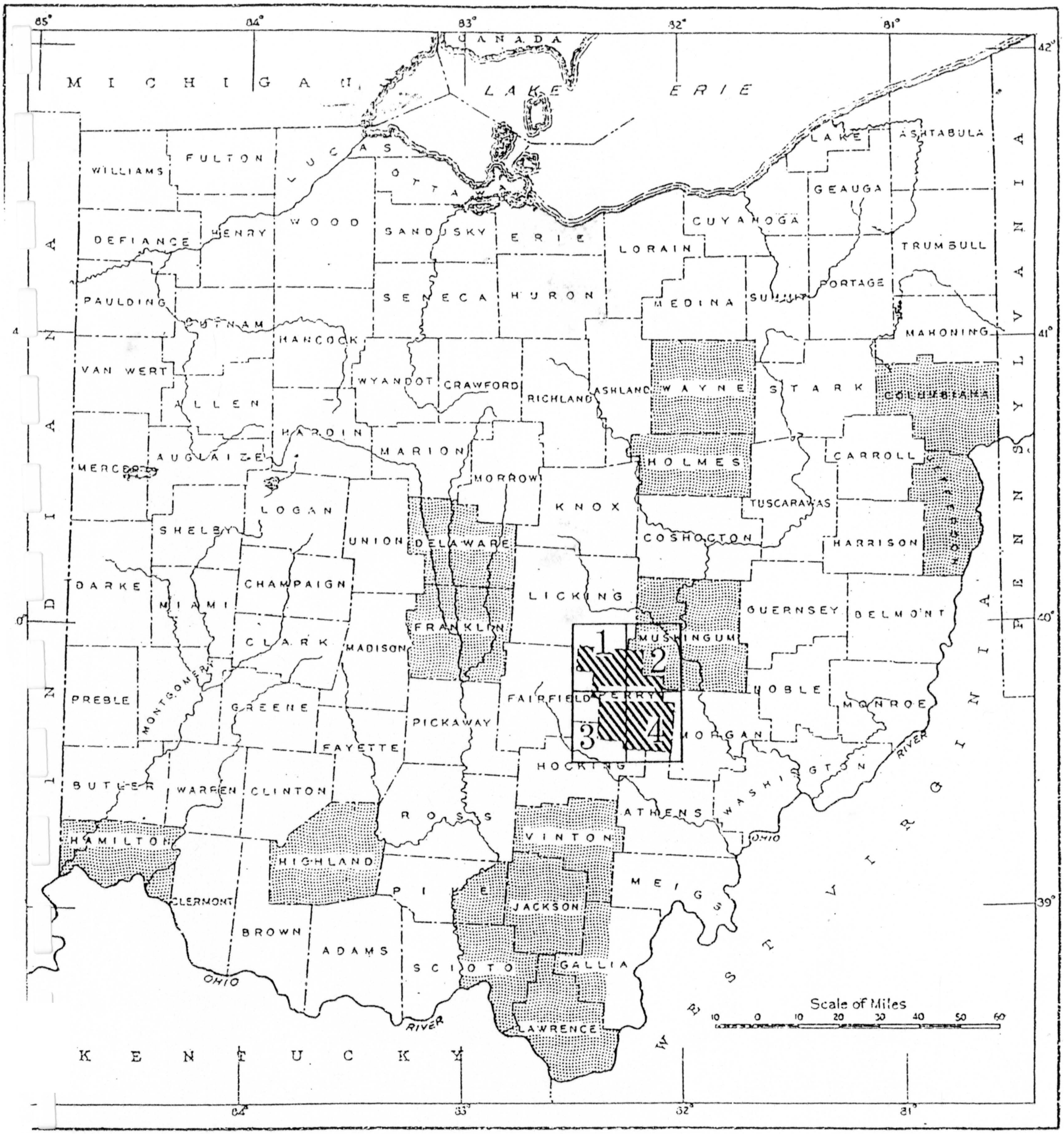


Figure 1—Index Map From Flint, 1951

Showing the location of Perry County in the State and the f...

TABLE 5.—*Generalized stratigraphic column for the Allegheny Group of Ohio.*

Bed	Material
Upper Freeport No. 7	Coal, patchy.
Upper Freeport	Limestone and marly shale.
Bolivar	Coal, local, thin.
Bolivar	Clay, flint and plastic.
Upper Freeport	Shale or sandstone.
Dorr Run	Shale, marine, local.
Lower Freeport (Rogers)	Coal, patchy.
Lower Freeport	Limestone, local.
Lower Freeport	Shale or sandstone.
Upper Kittanning	Coal, seldom present.
Washingtonville (Yellow Kidney ore)	Shale, marine.
Middle Kittanning No. 6	Coal, persistent.
Leetonia	Limestone, local.
Red Kidney ore	Shale, siliceous.
Strasburg	Coal, local.
Oak Hill	Clay, flint and plastic.
Hamden	Limestone, nonpersistent.
Columbiana	Limestone, marine, local.
Lower Kittanning No. 5	Coal.
Lawrence	Coal, shaly, local.
Kittanning	Shale and sandstone.
Ferriferous	Ore, irregular.
Vanport	Limestone, marine.
Scrubgrass	Coal, seldom present.
Clarion No. 4a	Coal, patchy.
Canary	Ore, very local.
Clarion	Sandstone, irregular.
Winters	Coal, very local.
Zaleski	Flint, impure, marine.
Ogan	Coal, local.
Putnam Hill	Limestone, marine.
Brookville No. 4	Coal, persistent.

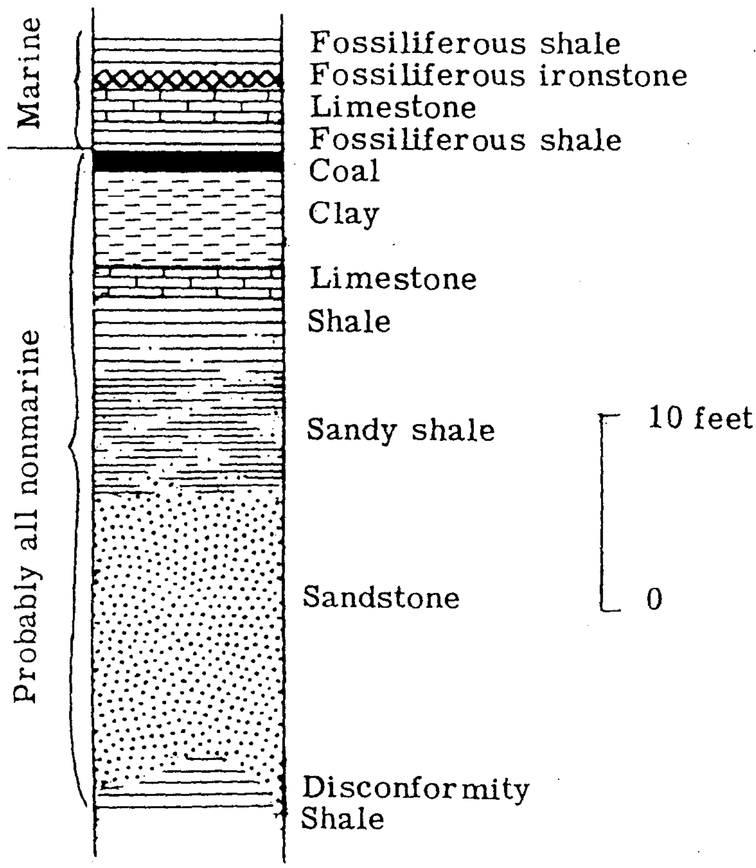
From Collins, 1979

Figure 6

TABLE 6.—*Generalized stratigraphic column for the Conemaugh Group of Ohio*

Bed	Material
Upper Pittsburgh	Limestone, irregular.
Upper Little Pittsburgh	Coal, very local.
Bellaire	Sandstone, local.
Lower Little Pittsburgh	Coal, seldom present.
Summerfield (Lower Pittsburgh)	Limestone.
Connellsville	Sandstone, local.
Clarksburg	Coal, local.
Clarksburg	Limestone and marly shale.
Morgantown	Sandstone, local.
Elk Lick	Coal, usually wanting.
Elk Lick	Limestone and marly shale.
Birmingham	Shale, siliceous.
Skelley	Limestone, local, marine.
Duquesne	Coal, seldom evident.
Gaysport	Limestone, siliceous, marine.
Ames	Limestone, marine.
Ames	Coal, very local.
Harlem	Coal, persistent.
Rock Riffle	Limestone, very local.
Round Knob-Pittsburgh	Clay, calcareous.
Saltzburg	Sandstone, local.
Barton	Coal, local.
Ewing	Limestone, ferruginous.
Cow Run	Sandstone, local.
Portersville	Limestone, marine.
Anderson	Coal, persistent.
Bloomfield	Limestone, local.
Cambridge	Limestone, marine.
Wilgus	Coal, nonpersistent.
Buffalo	Shale or sandstone.
Upper Brush Creek	Limestone, marine.
Upper Brush Creek	Coal, local.
Lower Brush Creek	Limestone and shale, marine.
Lower Brush Creek	Coal, local.
Mason	Coal, local.
Upper Mahoning	Shale or sandstone.
Mahoning (Groff)	Coal.
Thornton	Clay, irregular.
Mahoning	Limestone, local.
Lower Mahoning	Shale or sandstone.

Figure 7



From Flint, 1951

Figure 2. - Diagram of a composite cyclothem

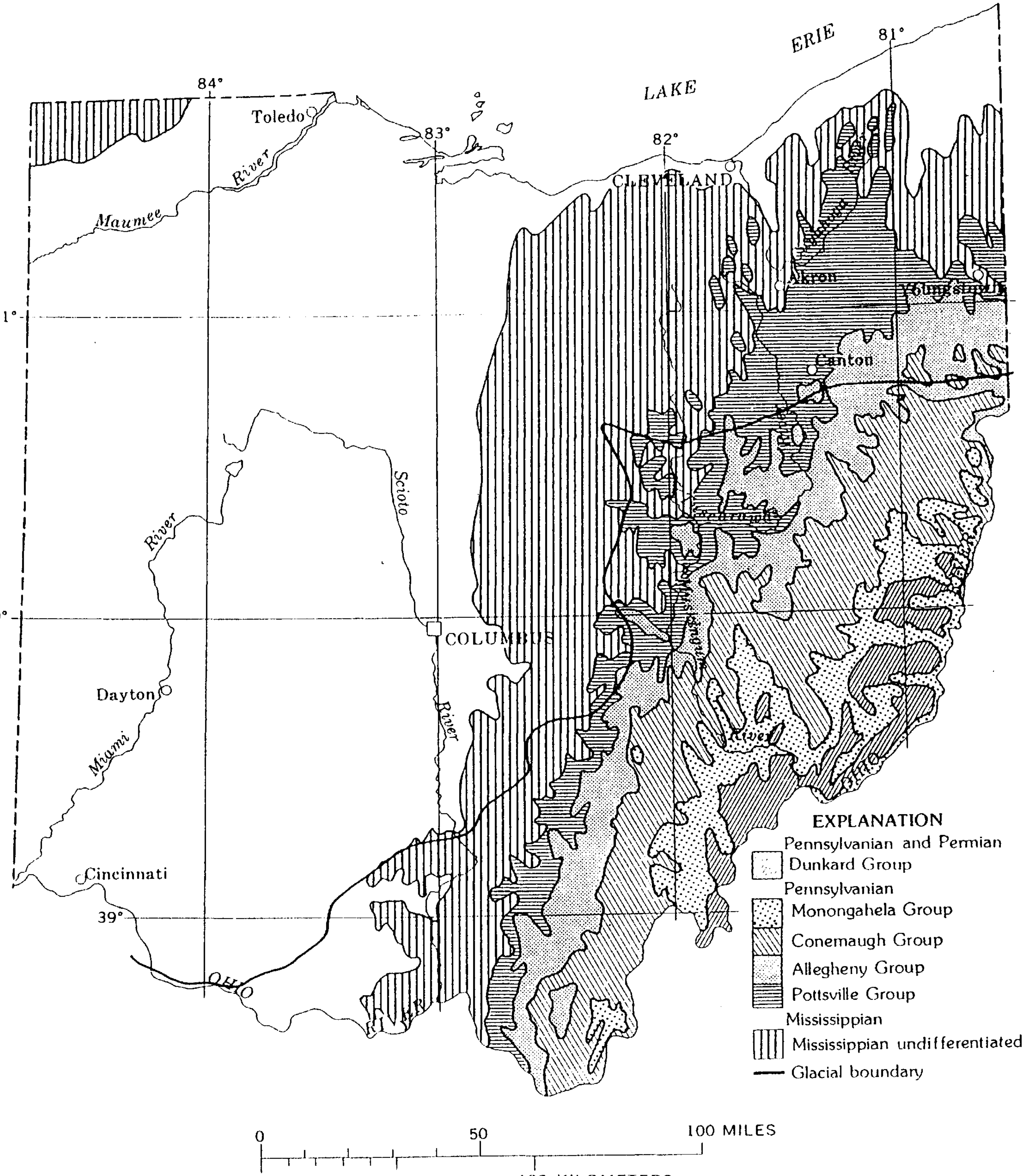


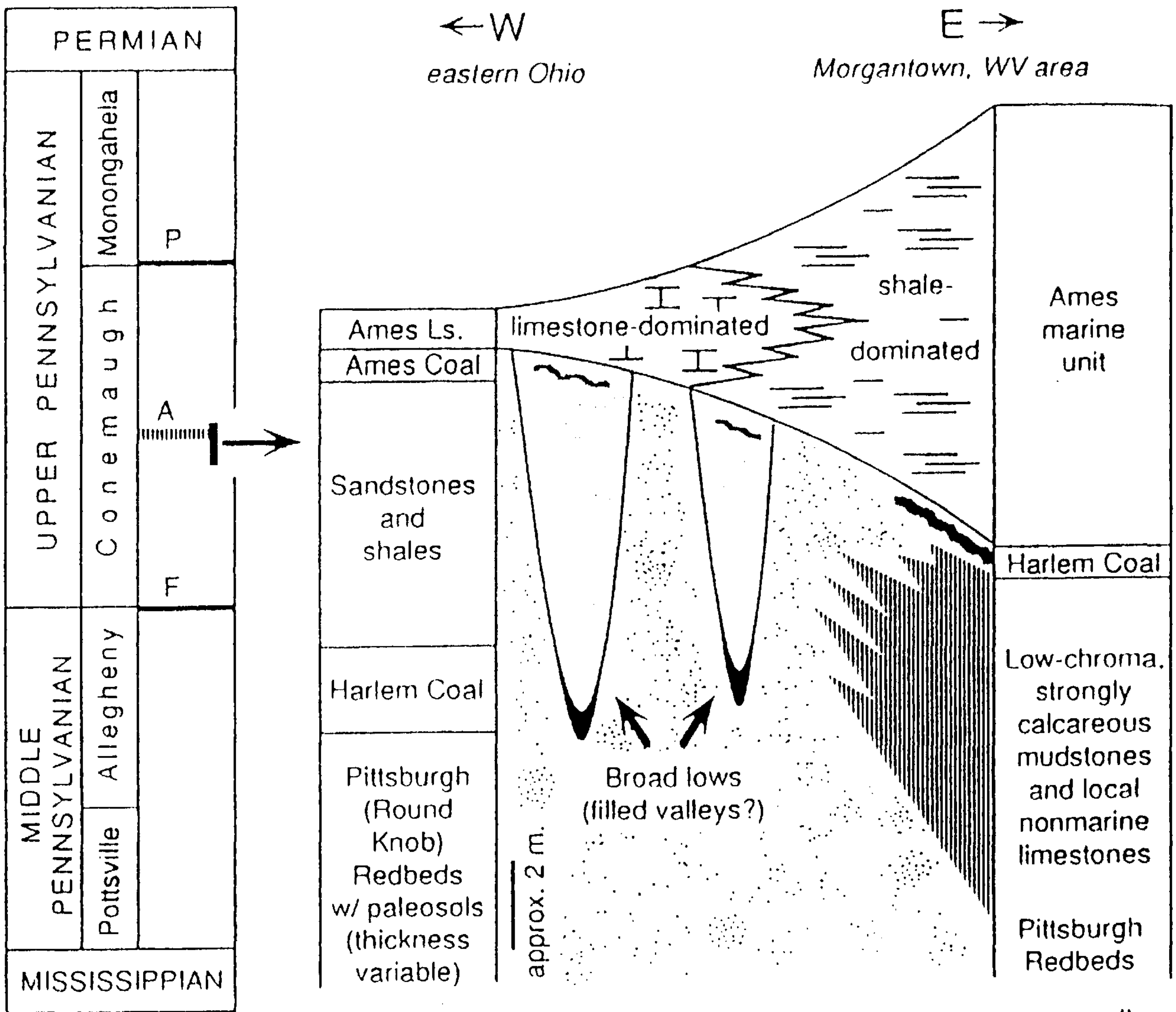
Figure 3 —Extent of Carboniferous rocks of Ohio (modified from King and Beikman, 1974).

From Collins, 1979

SYSTEM	GROUP	FORMATION OR BED	MEMBER
PERMIAN	Dunkard	Washington (No. 12) coal	
PERMIAN—PENNSYLVANIAN			
PENNSYLVANIAN	Monongahela	Waynesburg (No. 11) coal Pittsburgh (No. 8) coal	
	Conemaugh	Ames Limestone	
	Allegheny	Upper Freeport (No. 7) coal Brookville (No. 4) coal	
	Pottsville	Sharon Conglomerate	
MISSISSIPPIAN	Waverly	Maxville Limestone	
		Logan Formation	Vinton Sandstone Allensville Conglomerate Byer Sandstone
		Cuyahoga Formation	Berne Conglomerate Black Hand Sandstone Portsmouth Shale Buena Vista Sandstone Henley Shale
		Sunbury Shale	
		Berea Sandstone	
		Bedford Shale	Sagamore Shale Euclid Shale
DEVONIAN		Ohio Shale	Cleveland Shale Chagrin Shale Huron Shale

FIGURE 4—Generalized stratigraphic column of the Carboniferous section of Ohio (including immediately overlying and underlying units).

From Collins, 1979



(highly schematic; vertical scale greatly exaggerated)

—Highly schematic stratigraphic scheme for sub-Ames interval and Ames marine unit in northern Appalachian Basin, U.S.A. Section at left shows position of Ames marine unit (A) and sub-Ames interval (line with arrow) in Conemaugh Group, relative to upper Freeport Coal (F) at top of Allegheny Group and Pittsburgh Coal (P) at base of Monongahela Group. Schematic section at right shows detail of Ames and sub-Ames interval. Ames marine unit generally thickens and becomes carbonate-poor eastward. Harlem Coal is discontinuous in Ohio and Pennsylvania, and appears to have been deposited selectively in broad, shallow valleys or other lows.

Figure 8 From Joeckel

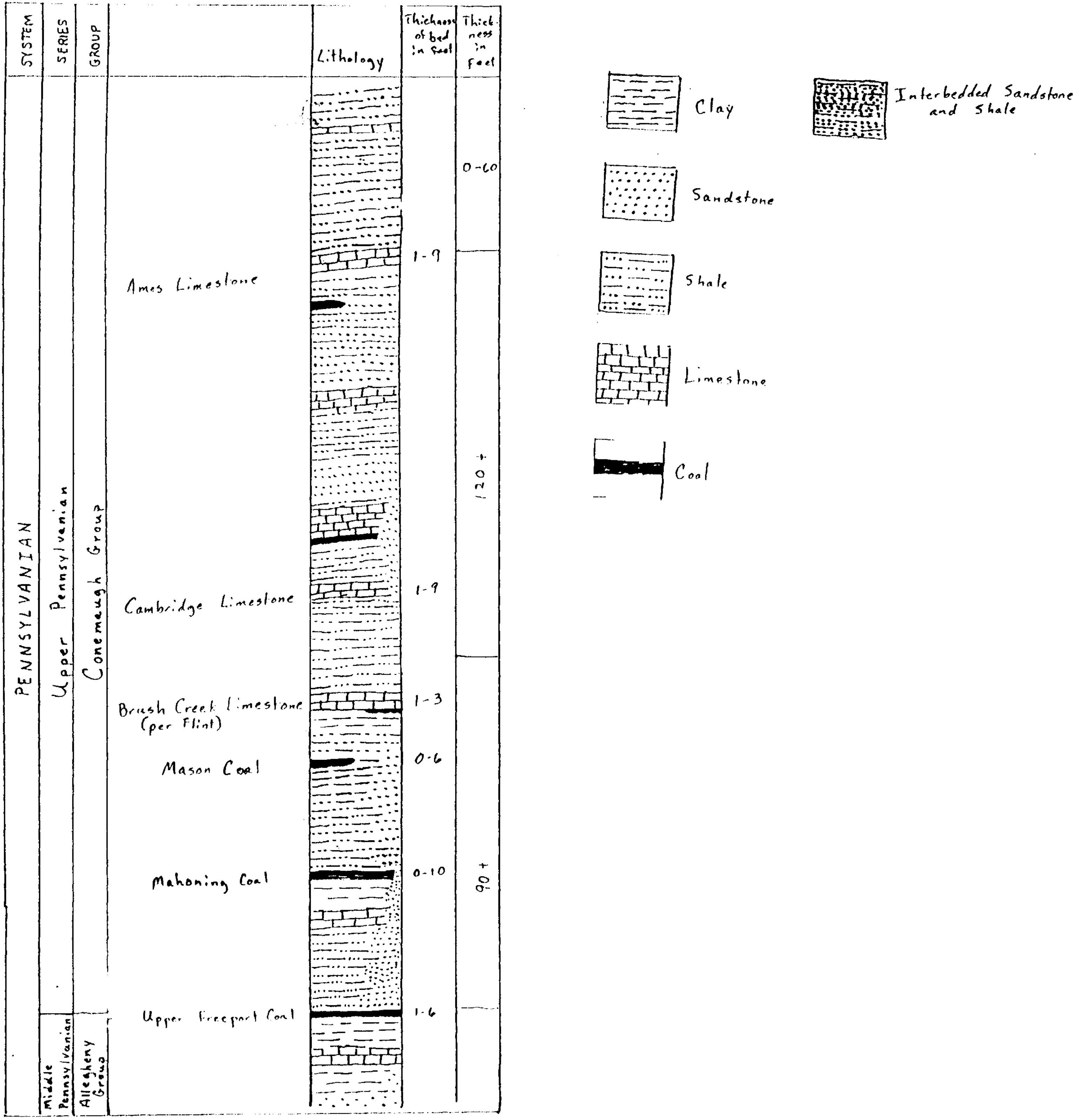


Figure 9
Stratigraphy modified from Flint, N.K., Geology of Perry County, Ohio Geological Survey Bulletin 48, 1951.